Statics

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Other Disciplines FE Specifications

Topic: Statics 8-12 FE exam problems	Exam Problem Numbers
A. Resultants of force systems and vector analysis	45,48,49
B. Concurrent force systems	51
C. Force couple systems	
D. Equilibrium of rigid bodies	46,47,50,52
E. Frames and trusses	51, 64
F. Area properties(e.g. centroids, moments of inertia, radius of gyration)	
G. Static friction	52,

We are grateful to NCEES for granting us permission to copy short sections from the FE Handbook to show students how to use Handbook information in solving problems. This information will normally appear in these videos as white boxes.

1. Which of the following statements is <u>not</u> one of Newton's Laws of Motion?

   A) The acceleration of a body is proportional to any unbalanced force acting on the body.

   B) The forces between two bodies in contact are equal, opposite, and have the same line of action.

   C) The force acting on a rope must always be such that the rope is in tension and cannot vary along the rope.

   D) A body remains at rest, or in a straight line at constant velocity, unless acted upon by an unbalanced force.

1. Which of the following statements is <u>not</u> one of Newton's Laws of Motion?

   A) The acceleration of a body is proportional to any unbalanced force acting on the body.

      Newtons 2nd law (F=ma)

   B) The forces between two bodies in contact are equal, opposite, and have the same line of action.

      Newton's 3rd law

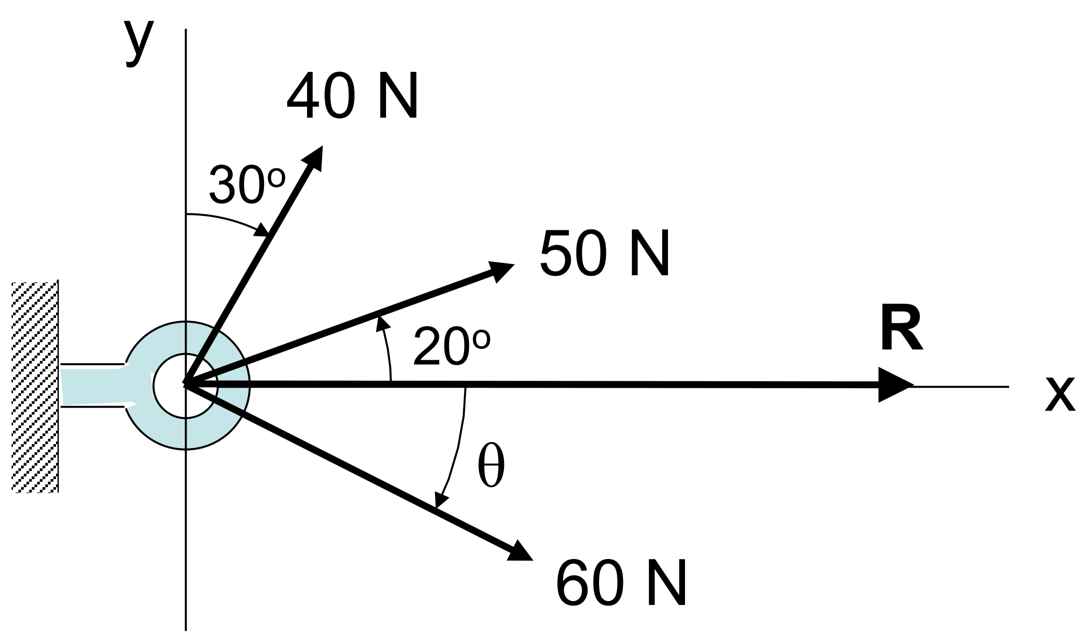
   C) The force acting on a rope must always be such that the rope is in tension and cannot vary along the rope.

      True, but not one of Newton's laws

   D) A body remains at rest, or in a straight line at constant velocity, unless acted upon by an unbalanced force.

      Newton's 1st law

2. At what angle (θ) should the 60 N force act for the resultant (R) of the three forces shown to be along the x-axis?



A) 40^o B) 50^o C) 60^o D) 70^o

Solution – Pr oblem 2 (Page 72- Ref. Handbook)

Since the resultant R is along the x axis it has no vertical component. Hence the sum of the vertical components of the three forces that make up R must be zero, ie.

$$\sum F_v = 0$$

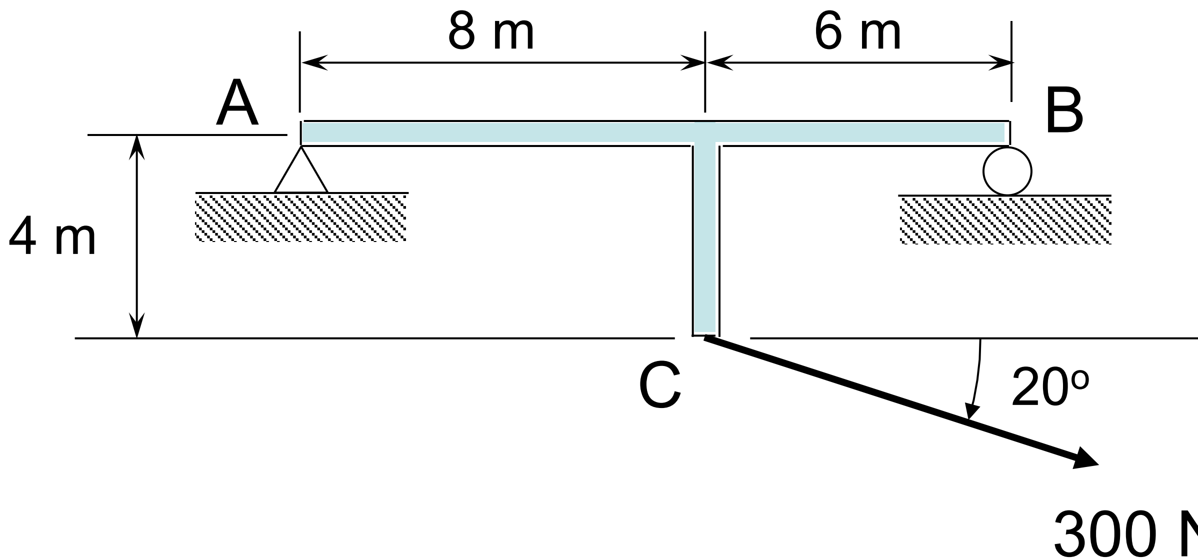
$$40 \cos 30^o + 50 \sin 20^o - 60 \sin \theta = 0$$

$$\sin \theta = \frac{(40)(.866) + (50)(.342)}{60} = 0.862$$

$$\theta = 59.8^O \approx 60^O$$

C)

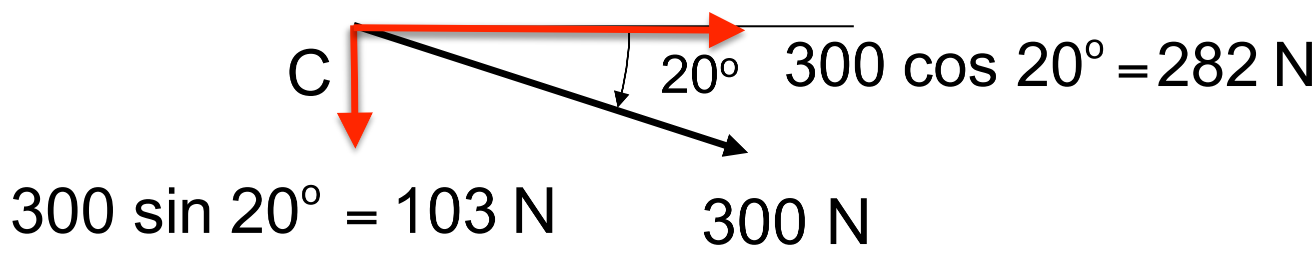
3. What is the moment of the 300 N force acting at point C of the beam shown about the pin support at point A?



A) 305 N·m (counterclockwise) B) 825 N·m (clockwise) C) 1130 N·m (counterclockwise) D) 1950 N·m (clockwise)

Solution – Problem 3 (Page 72- Ref. Handbook)

It is easiest to first resolve 300 N force at C into vertical and horizontal components.



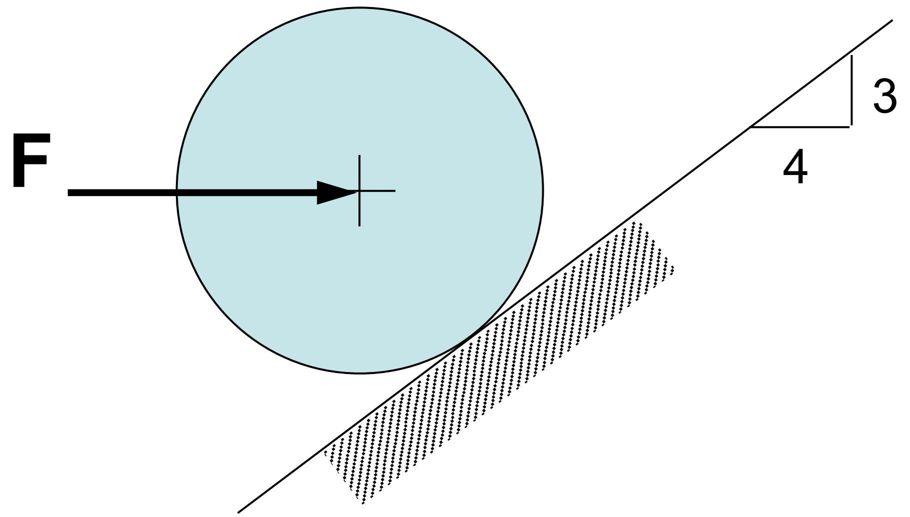
Now calculate moment from both components about point A. (clockwise +)

$$M_A = (103\ \text{N})(8\ \text{m}) - (282\ \text{N})(4\ \text{m})$$

$$= 824\ \text{Nm} - 1128\ \text{Nm} = -\ 304\ \text{Nm}$$

A)

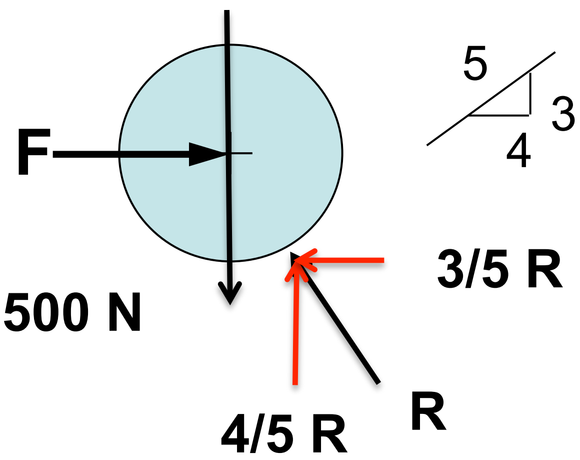
4. Determine the force (F) needed to hold the 500 N cylinder shown in equilibrium on the frictionless inclined surface.



A) 375 N B) 500 N C) 625 N D) 835 N

Solution – Problem 4

(Page 73 – Ref. Handbook)



Start with free body diagram of cylinder and break up surface reaction R into horizontal and vertical components.

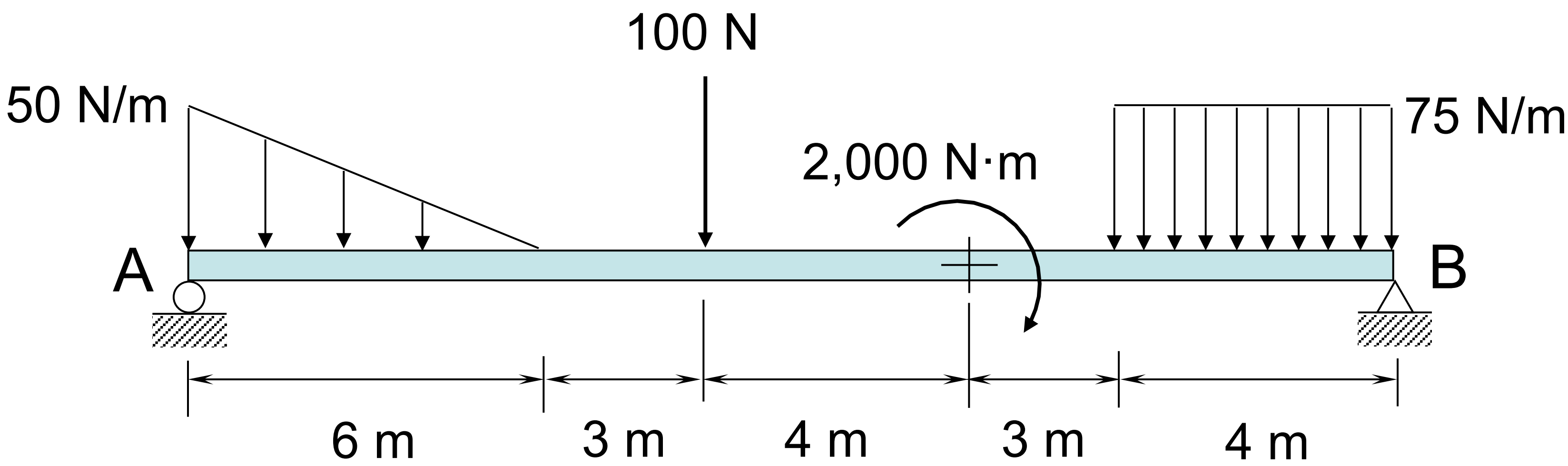
Apply equations of equilibrium

$$\sum F_H = 0 \qquad F = \frac{3}{5} R$$

$$\sum F_V = 0 \qquad 500\ \text{N} = \frac{4}{5} R \Rightarrow R = \frac{2500}{4}\ \text{N}$$

then $F = \frac{3}{5} R = \frac{1500}{4}\ \text{N} = 375\ \text{N}$ A)

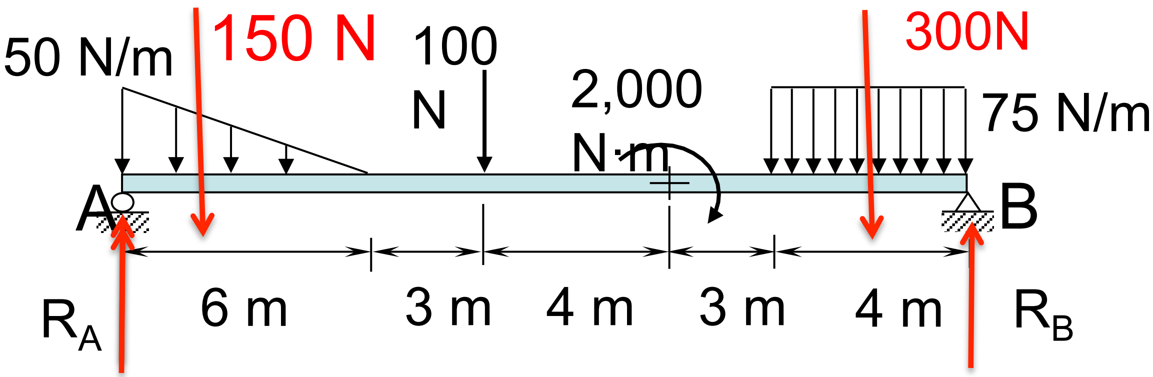
5. Determine the reaction at the roller support at point A for the loading on the beam shown.



A) 120 N B) 255 N C) 330 N D) 445 N

Solution – Problem 5

(Page 72 – Ref. Handbook)



First, determine resultants of distri–buted loads; area under distribution acting through centroid.

Apply moment equilibrium about point B to eliminate R_B from consideration.

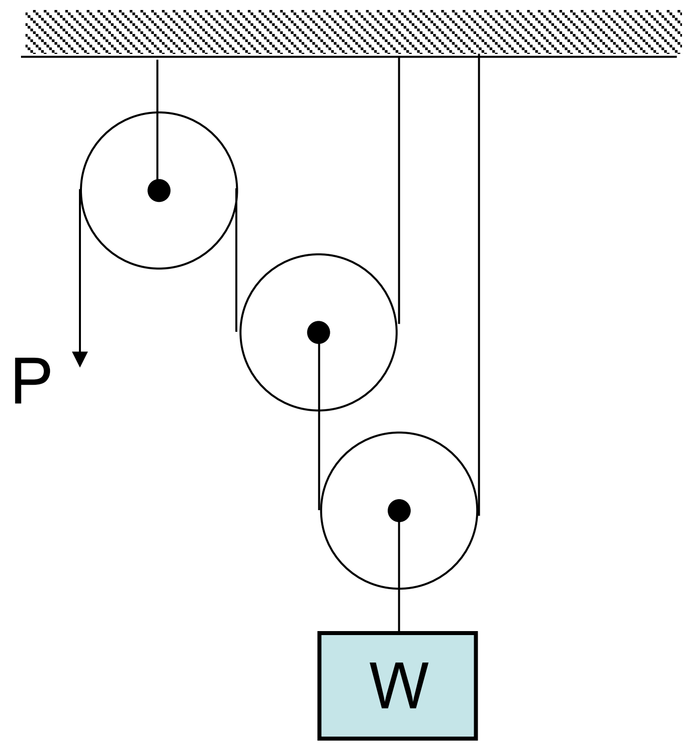
$$\sum M_B = 0$$

$$R_A(20) - 150(18) - 100(11) + 2000 - 300(2) = 0$$

$$R_A = \frac{2700 + 1100 - 2000 + 600}{20} = 120N$$

A)

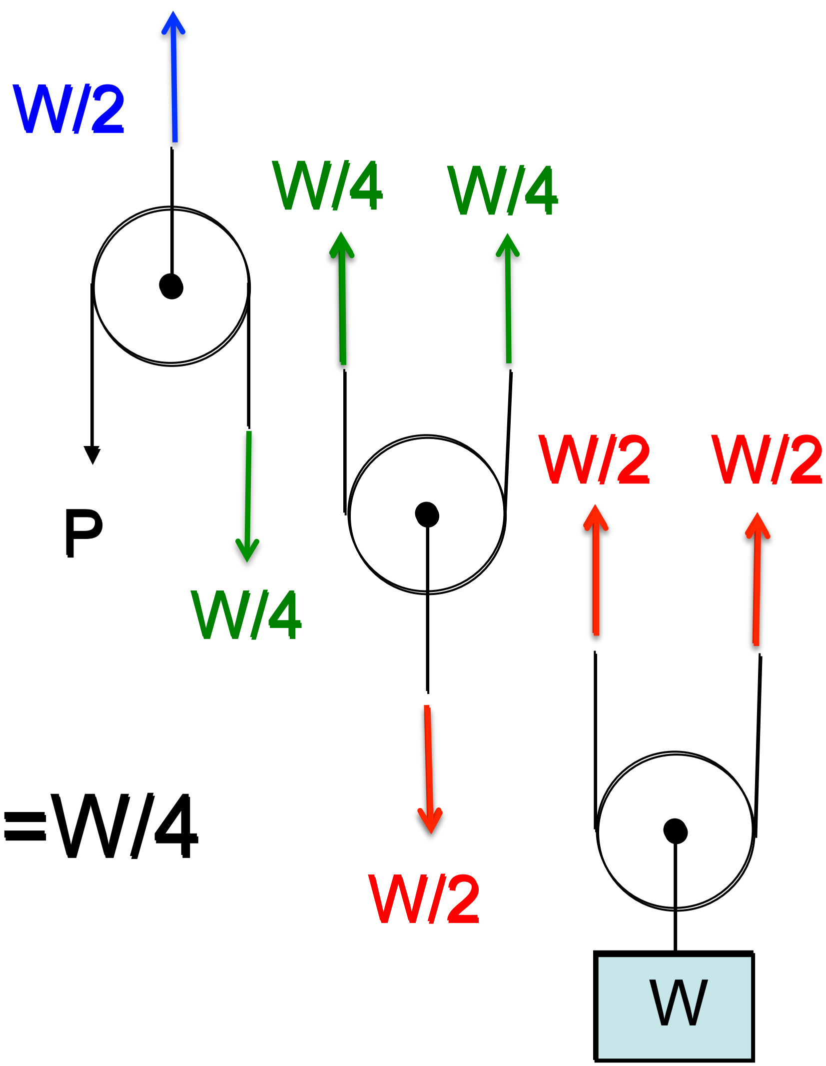
6. What value of the force (P) in terms of the weight (W) is necessary for the pulley system shown to be in equilibrium?



A) W B) W ÷ 2 C) W ÷ 4 D) W ÷ 8

Solution – Problem 6

(Page 72 – Ref. Handbook)



P=W/4

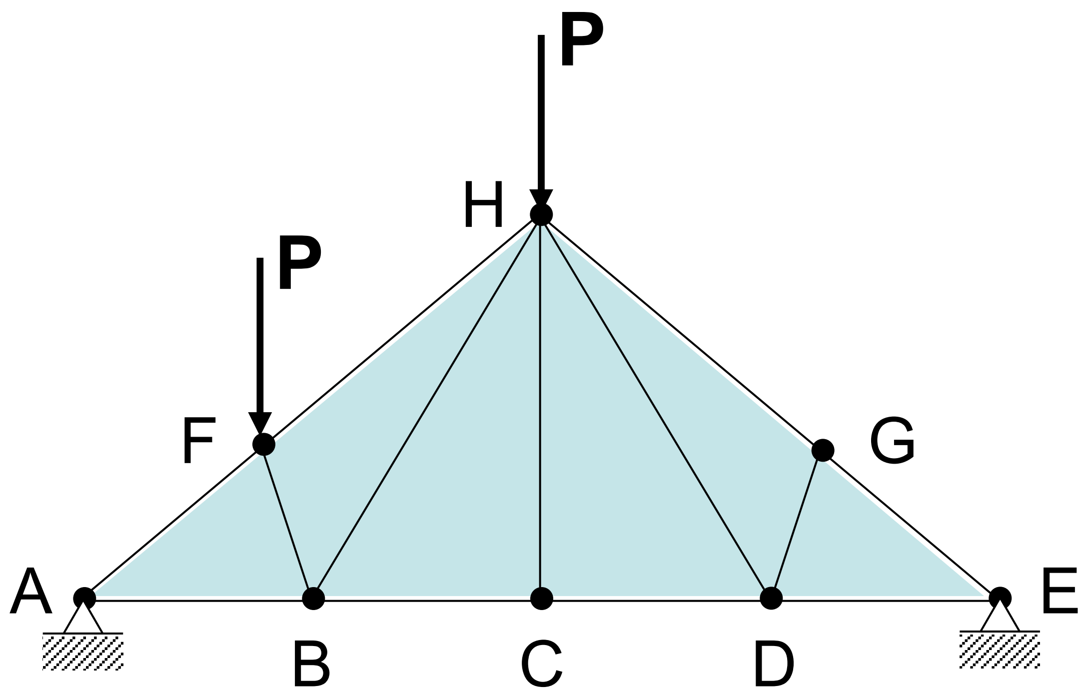
Draw free body daigram with all external forces on each pulley sequentially starting at the right recognizing that tension in cable over pulley is constant since there is no friction.

Check equilibrium of three atachments to fixed surface.

W/2+ W/4+ W/2=W+P

C)

7. Identify, if any, the zero force members of the truss shown. There are downward loads (P) acting only at joints F and H.



A) CH B) CH, DG C) CH, DG, DH D) None

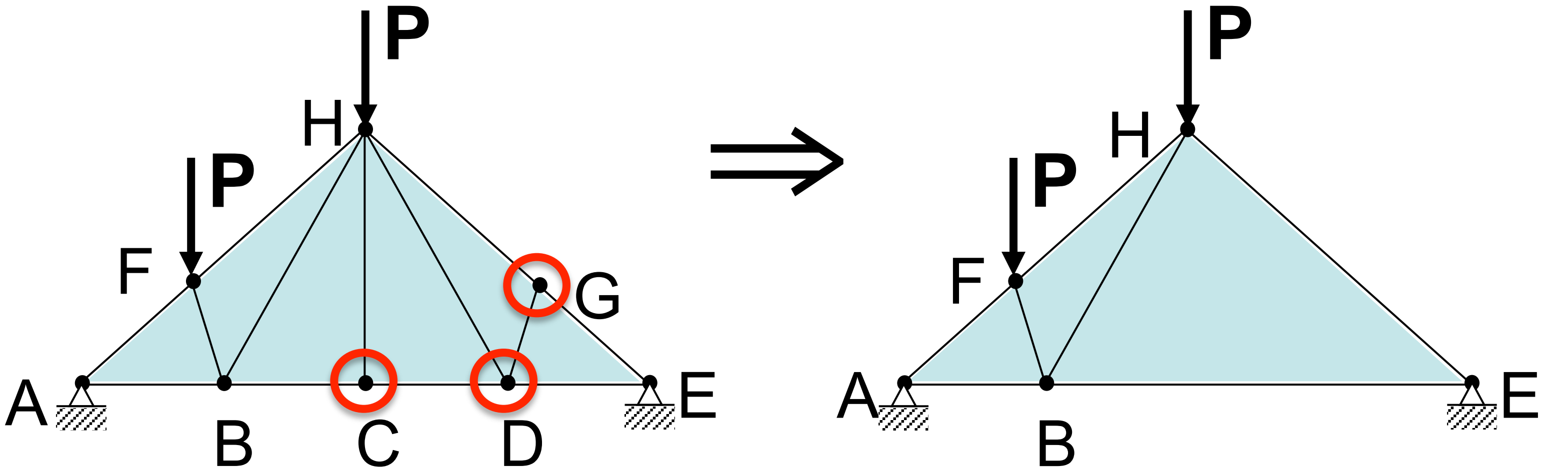
Solution – Problem 7 (Page 73 – Ref. Handbook)

Rule 1 -

If only two members form a truss joint and no external load or support reaction is applied at the joint, the members are zero force members.

Rule 2 –

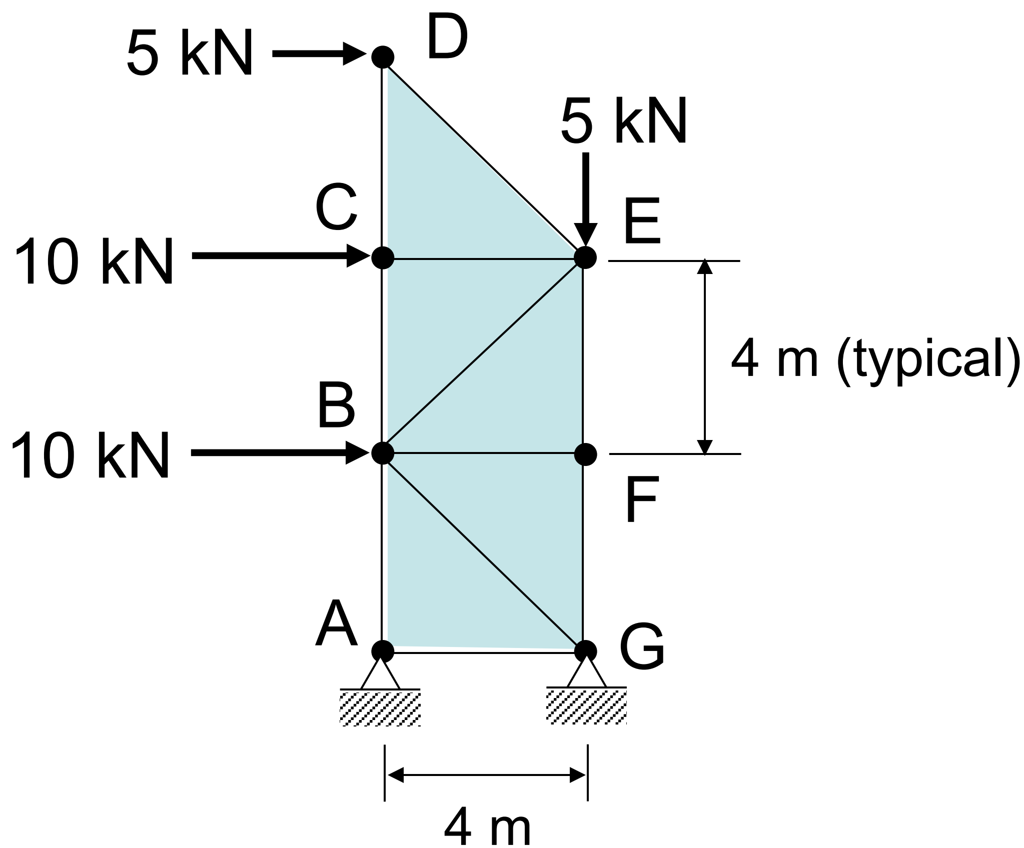
If three members form a truss joint for which two of the members are collinear the third member is a zero force strut provided no external force or support reaction is applied to the joint.



1. CH is a zero force member by Rule 2
2. DG is a zero force member by Rule 2
3. HD is a zero force member by Rule 2

ç)

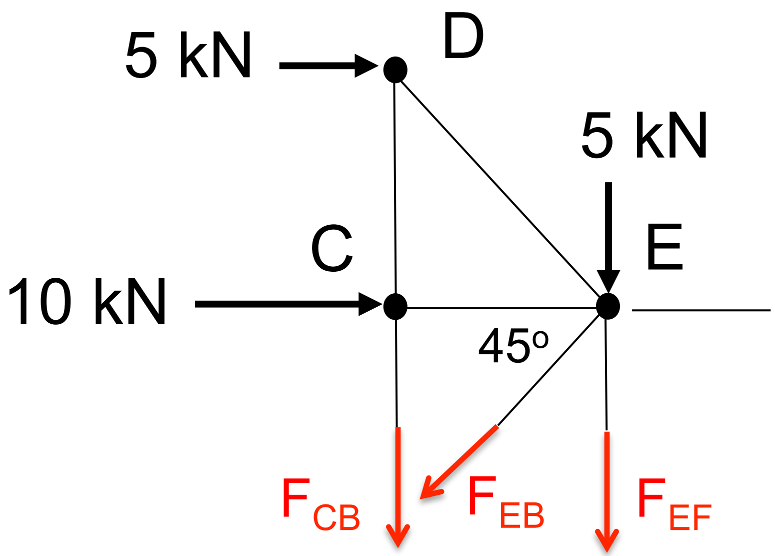
8. Determine the force in member EF of the truss shown.



A) 5 kN B) 10 kN C) 21 kN D) 25 kN

Solution – Problem 8

(Page 73 – Ref. Handbook)



Use method of sections with free body diagram on left. Apply equilibrium equations to solve for 3 unknown forces.

$$\sum M_E = 0 \qquad 5\text{ kn}(4) - F_{CB}(4) = 0 \Rightarrow F_{CB} = 5\text{ kn}$$

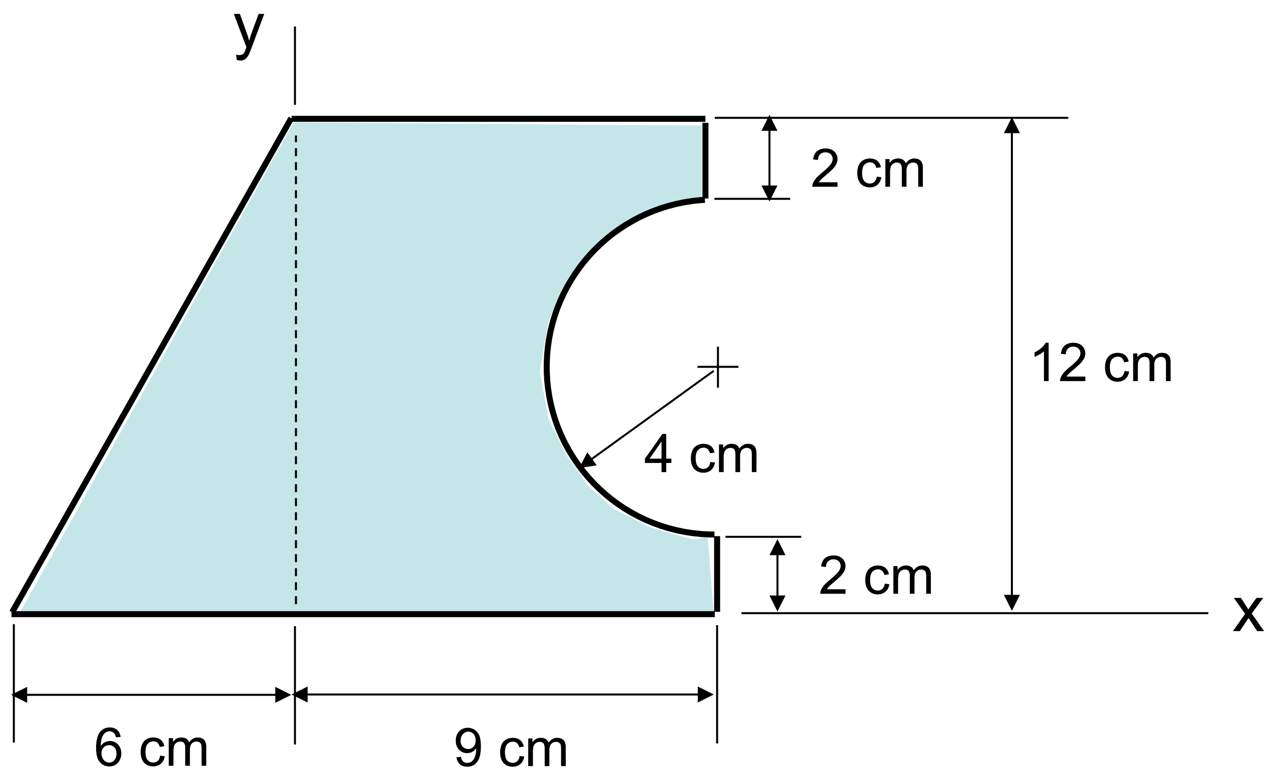
$$\sum F_{hort} = 0 \qquad 10\text{ kn} + 5\text{ kn} - F_{EB}\cos 45^o = 0$$

$$F_{EB} = {15\text{ kn}}/{0.707} = 21.2\text{ kn}$$

D)

$$\sum F_{vert} = 0 \qquad F_{EF} + 5\text{kn} + 5\text{kn} + 21.2(0.707) = 0 \quad F_{EF} = -25\text{ kn}$$

9. Locate the centroid of the composite area shown relative to the given xy coordinate system.



A) $\bar{x} = 1.2$ cm, $\bar{y} = 4.5$ cm

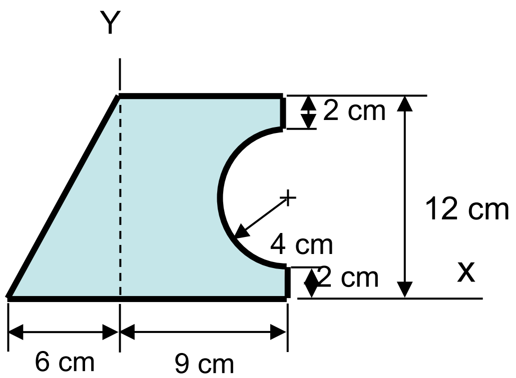
B) $\bar{x} = 1.9$ cm, $\bar{y} = 5.4$ cm

C) $\bar{x} = 2.4$ cm, $\bar{y} = 5.0$ cm

D) $\bar{x} = 3.0$ cm, $\bar{y} = 4.5$ cm

Solution – Problem 9

Page 74-76- Ref. Handbook



Use definition of centroid

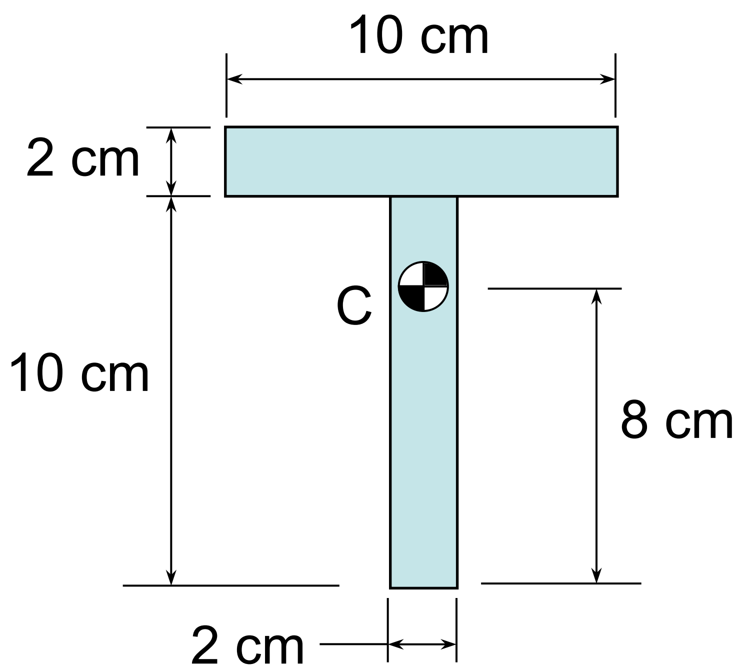
$$\bar{x} = \frac{\sum A_i x_i}{\sum A_i} \qquad \bar{y} = \frac{\sum A_i y_i}{\sum A_i}$$

Section	A_i (cm^2)	x_i (cm)	y_i (cm)	$A_i x_i$ (cm^3)	$A_i y_i$ (cm^3)
triangle	36	-2	6	-72	144
rectangle	108	4.5	6	486	648
semi - circle	-25.1	7.3	6	-183.5	-150.8
Summation	118.9			230.5	641.2

$$\bar{x} = \frac{230.5}{118.9} = 1.94 \text{ cm}, \quad \bar{y} = \frac{641.2}{118.9} = 5.39 \text{ cm}$$

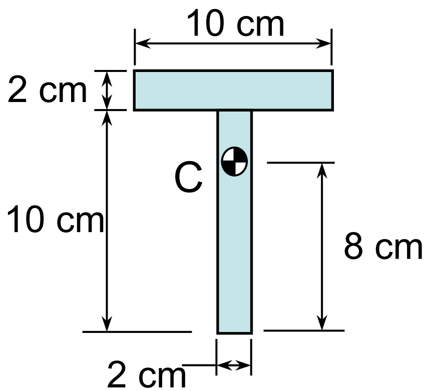
B)

10. Determine the moment of inertia of the Tee section shown about its horizontal centroidal axis, which has been located.



A) 173 cm^4 B) 343 cm^4 C) 533 cm^4 D) 753 cm^4

Solution – Problem 10 (Page 74-76 – Ref. Handbook)



Use parallel axis theorem

$$I_C = \left(I_t + A_t d_t^2\right) + \left(I_b + A_b d_b^2\right)$$

$$I_{rect} = \frac{bh^3}{12}$$

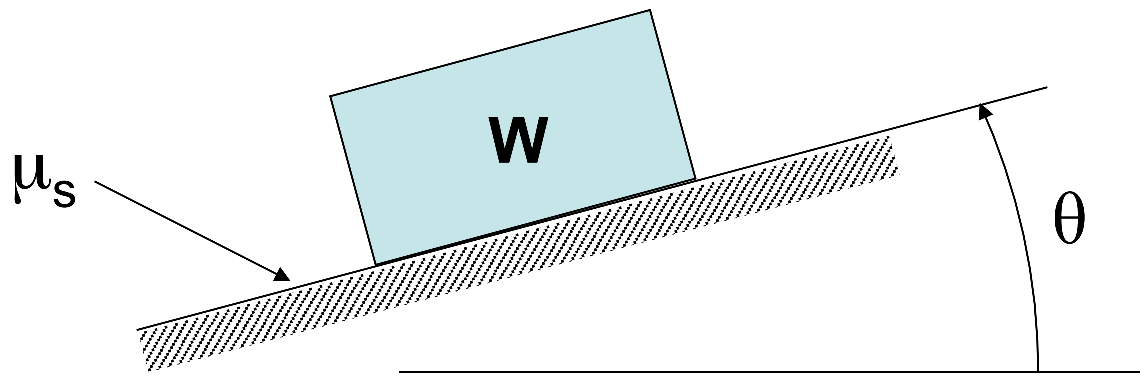
$$I_t = \frac{(10)(2^3)}{12} = 6.67\ cm^4, \quad A_t = (10)(2) = 20\,cm^2, \ d_t = 2 + 1 = 3\,cm$$

$$I_b = \frac{(2)(10^3)}{12} = 166.7\ cm^4, \ A_b = (2)(10) = 20\,cm^2, \ d_b = 8 - 5 = 3\,cm$$

$$I_C = (6.67 + 20\,x\,3^2) + (166.7 + 20\,x\,3^2) \ = 533.3\ cm^4$$

C)

11. What is relationship between the maximum angle (θ) for impending slipping of the block on the incline and the coefficient of static friction (μ_s).



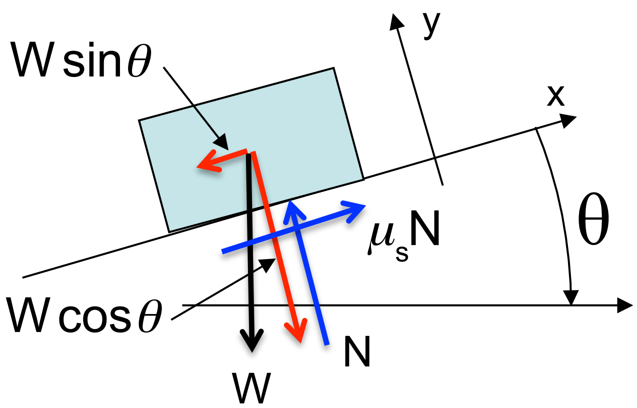
A) $\sin\theta_{max} = \mu_s$

B) $\cos\theta_{max} = \mu_s$

C) $\tan\theta_{max} = \mu_s$

D) $\sec\theta_{max} = \mu_s$

Solution – Problem 11 (Page 73 – Ref. Handbook)



Slippage will begin to take place when component of W along plane is equal to $\mu_s N$.

Apply equilibrium to all forces on free body diagram of block.

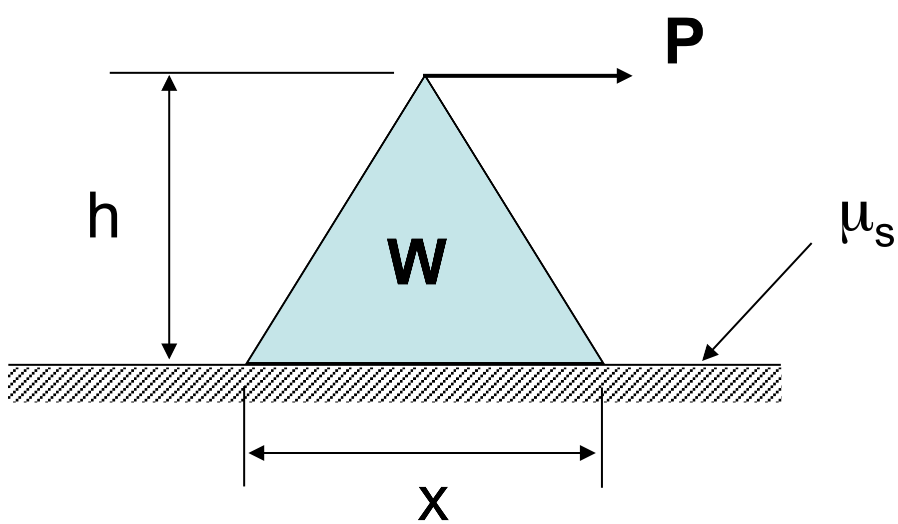
$$\sum F_y = 0 \quad N - W\cos\theta = 0 \quad \Rightarrow \quad N = W\cos\theta$$

$$\sum F_x = 0 \quad \mu_s N - W\sin\theta = 0 \quad \text{or}$$

$$\mu_s W\cos\theta = W\sin\theta \quad \Rightarrow \quad \mu_s = \frac{\sin\theta}{\cos\theta} = \tan\theta$$

C)

12. Determine an algebraic expression that relates the width (x) of the triangular block to its height (h) and the coefficient of static friction (μ_s) for the block to as likely slip as it is to tip.



A) $x = \mu_s h$

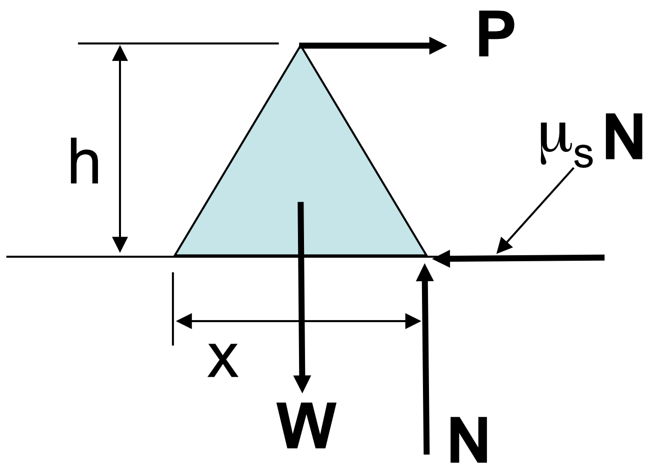
B) $x = 2 \mu_s h$

C) $x = 3 \mu_s h$

D) $x = 4 \mu_s h$

Solution – Problem 12

Pg 72-73 - Ref. Handbook



At instant of tipping forces on block will be as shown on left. Satisfy equations of equilibium for assumed force system.

$$\sum F_{horizontal} = 0 \qquad P = \mu_s N$$

$$\sum F_{vertical} = 0 \qquad W = N$$

$$\sum M_o = 0 \qquad P(h) = W\left(\frac{x}{2}\right) \quad \text{or}$$

$$\mu_s W(h) = W\left(\frac{x}{2}\right) \quad \Rightarrow \quad x = 2\mu_s h$$

B)